Starshade Stray Light Mitigation through Edge Scatter Modeling and Sharp-Edge Materials Development

Completed Technology Project (2014 - 2015)

Project Introduction

Identification and characterization of nearby habitable exoplanets has been identified by the Astro2010 Decadal survey as the most important science frontier in Astronomy for the coming decade. This proposal seeks to develop the starshade technology which will allow NASA to directly image and obtain spectra of nearby exoplanets, including exo-Earths. To detect and characterize planets using a starshade, one of the key sources of noise that must be controlled is the stray light. The characteristics of the edge of the starshade are critical to control the scattered light from our own sun. Even though the edge is illuminated at an oblique angle compared to the telescope, the allowed scattered light is ~1e-25 of the incident light or less than 2.4e-12 Jy. The current TRL of this aspect of the starshade technology is evaluated at 3 as we have a concept and have built both a model (Casement et al, 2012) and several representative tips and edges, but not to flight tolerances from flight materials. We propose to explore material options for the edge and to demonstrate, via modeling and fabrication, that this requirement can be met. The radius of curvature of the edge and its scatter properties when illuminated are the critical parameters that must be specified and are critical to modeling of the full system. We propose to build sample coupons of flight-like material, treat them with options for coatings identified via literature search, and then measure the bidirectional reflectance distribution function (BRDF). Screening tests at a single wavelength will reduce the number of options from ~6 to 2 for further testing. We have teamed with The Scatter Works to provide the BRDF measurements which will be measured across the wavelength range of interest for the two options which are the most promising. We will also do preliminary environmental testing on these options to determine if the material + surface treatment is likely to survive the launch and space environment. To validate the overall system performance, we have teamed with Photon Engineering to provide a detailed stray light model to validate the results discussed in Casement et al. The BRDF measurements will be incorporated into the model to determine the required edge radius of curvature to meet the solar stray light requirement. To achieve TRL 4, we will build a sample of an edge similar to the flight configuration with the required radius of curvature to demonstrate the requirements are achievable. The edge will be prepared as per the most promising sample previously tested. We will further measure the scatter properties from the edge at The Scatter Works. These activities will validate the approach for manufacturing the edge and show that the approach is feasible to meet the stringent stray light requirements for achieving the objectives of the mission.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Strategic Astrophysics Technology

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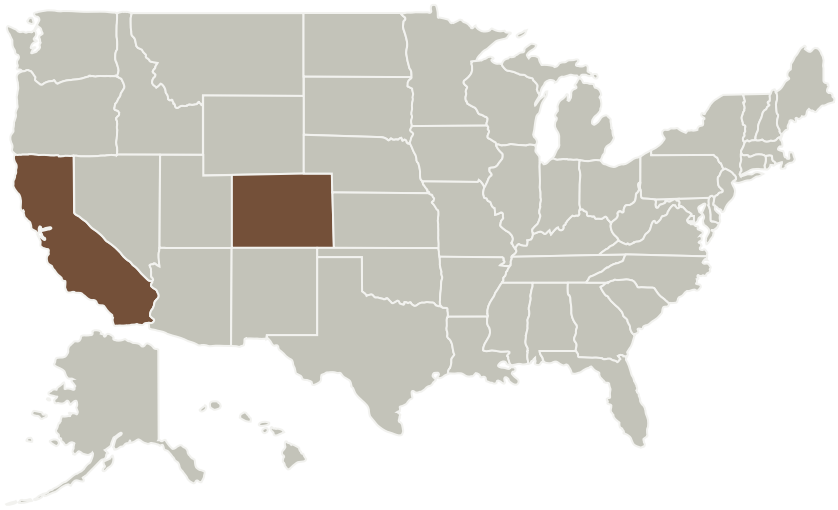
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Northrop Grumman Aerospace Systems(NGAS)	Supporting Organization	Industry	Redondo Beach, California
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations	
California	Colorado

Project Management

Program Director:

Mario R Perez

Program Manager:

Mario R Perez

Principal Investigator:

Lyla S Casement

Co-Investigators:

Webster Cash
Tiffany M Glassman

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.4 Information Processing
    - TX11.4.8 Edge Computing

Target Destination

Outside the Solar System